ARS 52-21
April 1967

ELECTRICALLY OPERATED GATES FOR LIVESTOCK MARKETS

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

The work reported here was done under a Research Cooperative Agreement between the U.S. Department of Agriculture and the University of Missouri Agricultural Experiment Station. The research was performed under the general supervision of Tarvin F. Webb, Investigations Leader, Transportation and Facilities Research Division, Agricultural Research Service, and Harold Walton, Chairman, Department of Agricultural Engineering, University of Missouri.

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Prepared by

Transportation and Facilities Research Division
Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

in cooperation with

Missouri Agricultural Experiment Station

ELECTRICALLY OPERATED GATES FOR LIVESTOCK MARKETS

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and J. S. McKibben [1]

SUMMARY

An electrically operated, remotely controlled gate for livestock markets has been designed, constructed, and tested. Two of these gates were used in the sales ring of an auction market for a year with no major maintenance or operational problems.

The gate can be opened without difficulty even with livestock crowded against it. The gate does not have to be in perfect alinement to latch or unlatch. The gate and latch mechanism were designed so that the gate can also be operated independently of the electrical system.

Use of the gates in the sales ring made it possible to reduce the crew in the selling cycle by two workers and also permitted sales to proceed more rapidly, because animals could be moved through the ring faster.

Estimated cost of the two gates used in the sales ring is about $2,500. The estimated saving in labor would justify use of the gates on auction markets operating one or more days per week.

Electrically operated, remotely controlled gates may be useful in other locations at livestock markets, but data are not available on the economic feasibility of such use.

BACKGROUND

A substantial amount of the labor used on the approximately 1,725 livestock auction markets and 58 terminal stockyards in the United States is involved in opening and closing gates to pens and to the sales ring to admit and release animals. Several attempts have been made to develop automatically controlled gates for livestock markets to reduce labor requirements, without much success. A few auction markets have installed hydraulic systems for opening and closing gates near the sales ring, but it is possible to hit and injure animals with hydraulically operated gates.

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An electrically operated gate, designed to stop in its opening or closing cycle when it comes in contact with an animal, would solve this problem. Of particular need in a livestock market, where animals press against gates and may cause them to get out of alinement, is a latch that would not be affected by misalinement.

A latch and a mechanism to operate the latch electrically were designed by the Transportation and Facilities Research Division, Agricultural Research Service. The Agricultural Engineering Department, University of Missouri, modified the design of the latch and latch mechanism and designed and constructed an electrically operated, remotely controlled gate. The latch mechanism and the electrical system were so designed that the gate can be latched and unlatched without difficulty even with animals pressing against it; the gate stops during opening or closing if it comes in contact with an animal; and the power to the gate also stops after a preset time.

Operation of all gate components was tested in the laboratory. Two gates were then installed at the entrance and exit of the sales ring on a livestock auction market and were used regularly in the sales operations for approximately 1 year.

This report describes the electrically operated gate and the tests made. Construction details and further information on the gate will be published in Missouri Agricultural Experiment Station publication B863, "Automatic Livestock Gate--Electrically Operated," now in preparation. Copies may be obtained from the Department of Agricultural Engineering, University of Missouri, Columbia, Mo. 65202.

OPERATION OF THE GATE

Movement of the gate is controlled by three pushbuttons--open, close, and emergency stop.

When the open button is pushed, power goes simultaneously to the solenoid that opens the latch and to the motor to move the gate. Power to the solenoid that opens the latch is turned off by a time delay relay after 1 to 2 seconds, and a spring returns the latch to the locked position. When the gate is nearly open, a limit switch turns off the motor.

When the close button is pushed, power goes to the motor to close the gate. When the gate is nearly closed, a limit switch turns off the motor and the gate coasts to the closed position; the closing force of the gate causes it to latch.

The emergency stop button is used to stop the gate in either its opening or closing arc so that the reverse cycle can be started. This provision for stopping the gate in midcycle provides a means of quickly correcting errors and prevents substantial time loss since the complete open and close cycle requires up to 20 seconds. The gate can be unlatched and operated by a hand lever independently of the electrical system.

THE LATCH AND LATCH MECHANISM

The gate latch and latch mechanism (fig. 1) provide for mechanical latching and electrical unlatching of the gate. The latch mechanism consists of a 230-volt electric solenoid, a transfer arm, an actuating rod, and a return spring. The latch consists of a striker or roller and a latch dog.

The striker is mounted with a vertical axis of rotation on a stationary post. The striker is about 2 inches in diameter and 1.25 inches long. The latch dog is mounted on the gate. The latch dog is a rectangle with one of the short sides curved. Basically, the striker and latch dog are cylinders. The latch dog would be a cylinder if the curve was extended to complete the circle; the latch dog is rotated around the center axis of the cylinder. The latch dog is 3.3 inches long, 1.5 inches wide, and 0.75 inch thick. The striker and latch dog are mounted on roller bearings to minimize rotation friction. In the latched position, the center line of the latch dog passes through the center of the striker, so a force applied to one cannot apply torque or twisting force to the other. This results in a latch that remains closed under the pressure exerted by livestock, but, at the same time, can be easily unlatched under this pressure.

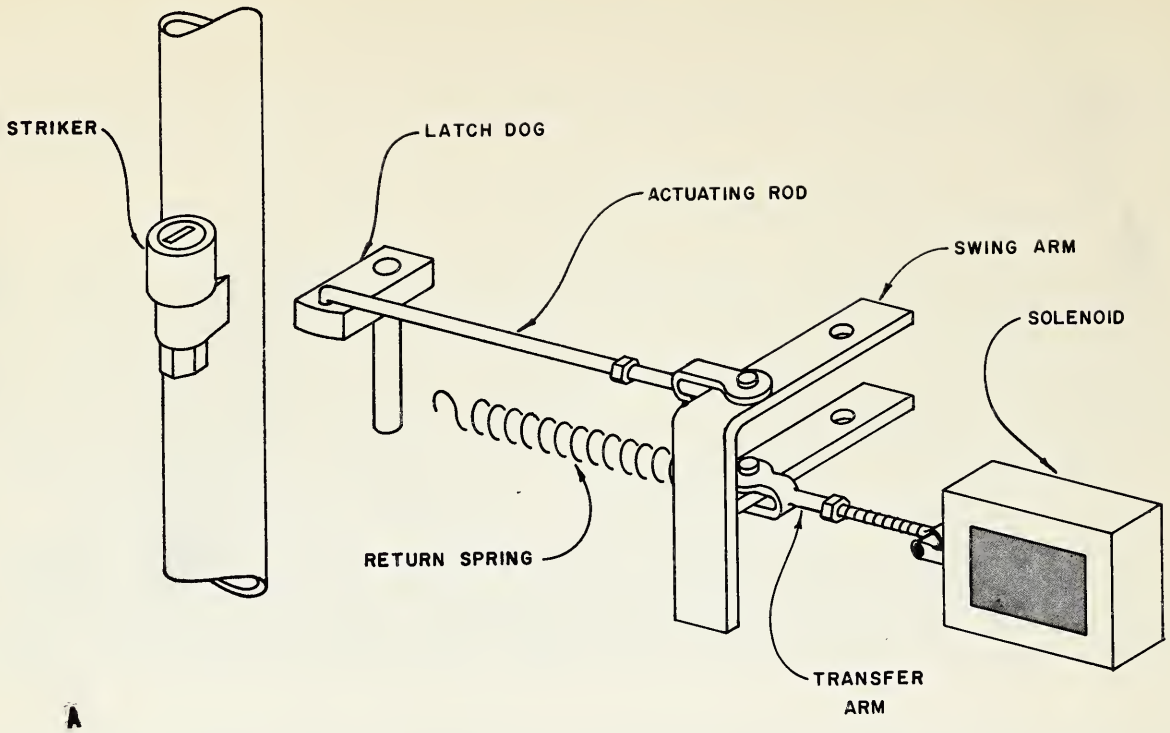
The solenoid, rated at 300 ounces pull over a distance of 1 inch, provides the force needed to unlatch the gate. This force is transmitted through the transfer arm to the actuating rod and then to the latch dog. The latch dog is rotated around its axis so that in the unlatched position it clears the striker. When the solenoid is not powered, the return spring holds the latch dog in the latched position. Figure 2 illustrates the opening of the gate.

When the gate is being closed, the latch dog does not have to be rotated by the solenoid to clear the striker and move into the latched position. As the gate closes, the flat side of the latch dog contacts the striker. The latch dog is rotated slightly by the force of the moving gate and thus moves past the striker. Once it clears the striker, the latch dog is rotated in the opposite direction by the return spring. The return spring holds the latch dog in the latched position.

THE ELECTRICALLY OPERATED GATE DRIVE SYSTEM

The power unit for opening and closing the gate consists of an electric motor and a gear reduction drive (fig. 3). The electric motor is rated at 1/2 horsepower and is operated on 230-volt, 3-phase electric current. The output shaft of the gear reduction drive is connected to a vertical shaft of the gate through a slip clutch. Control devices built into the system include limit switches and time delay relays. All of the electrical components used in the control circuits are standard shelf items that can be purchased at any reliable electrical supply firm.

The gear reduction drive chosen operates at 5.8 revolutions per minute (r.p.m.), which is very close to observed manual operating speed. Time studies



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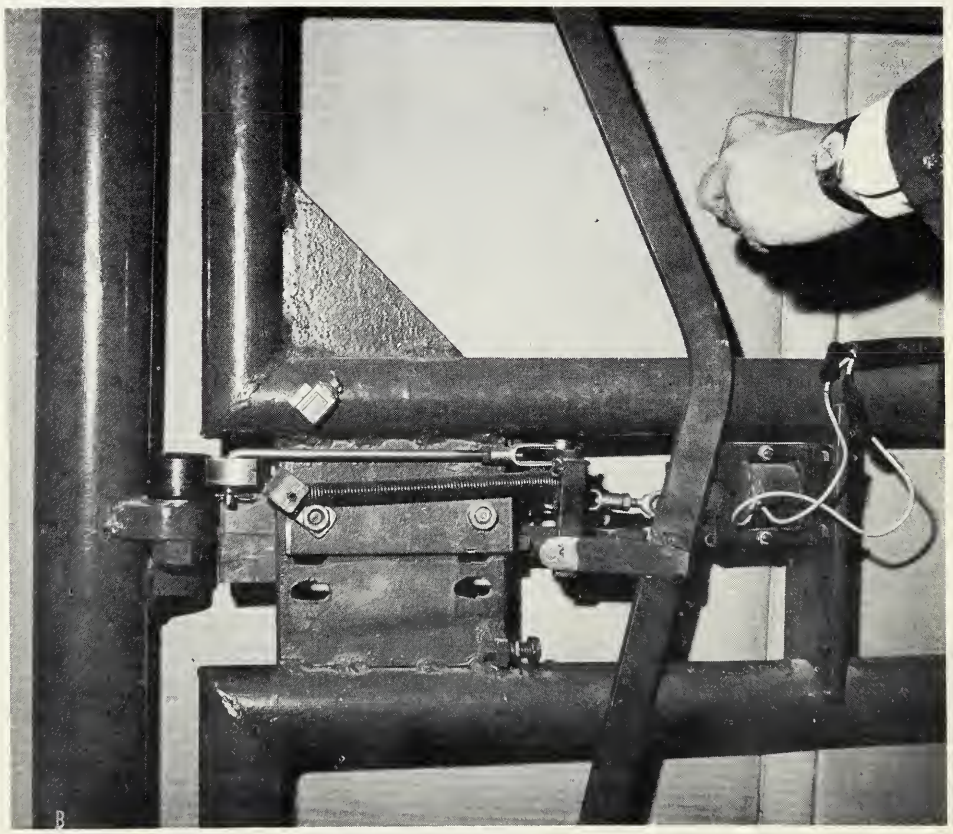

Figure 1.--(A) A schematic drawing of the latch and latch mechanism, and (B) the latch and latch mechanism installed on the gate.

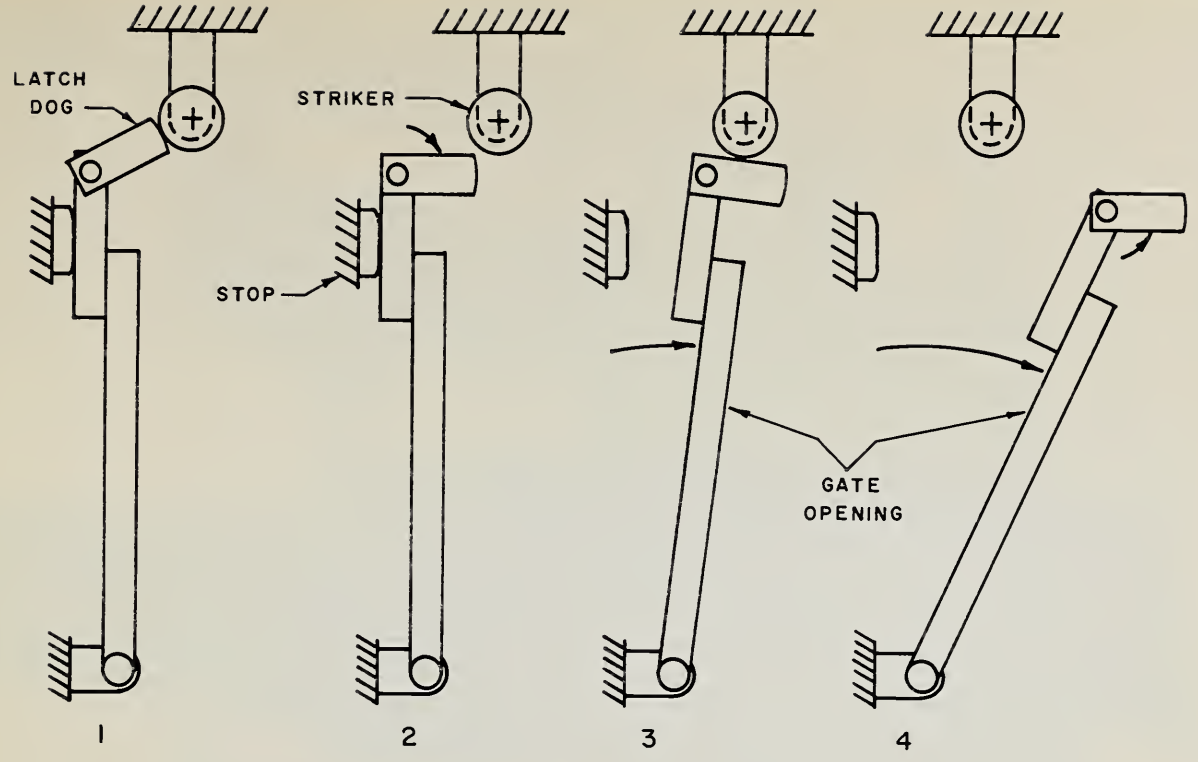

Figure 2.--Sequence of operations for opening the gate: (1) Gate is against stop with latch dog in latched position; (2) latch dog is rotated around its axis so that it clears the striker; (3) latch dog moves past striker as gate starts to open; and (4) latch dog is returned to latched position by return spring when solenoid is de-energized.

indicated that the minimum acceptable speed for the gate to move through a 90-degree arc is about 3 seconds, or 5 r.p.m. for the vertical shaft of the gate.

The slip clutch permits sufficient slippage in the gear drive to prevent injury to animals if the gate should come in contact with them in its opening or closing arc. A time delay relay automatically removes power from the gate after a preset time if an obstruction stops the movement of the gate. If the animal or other obstruction is removed before the programed time elapses, the gate will continue in its opening or closing arc.

In normal operation, that is, when the gate goes through its full arc without being stopped, the power is removed from the gate by limit switches that cut the flow of electrical energy to the motor.

The electrical solenoid that actuates the latching mechanism is equipped with a time delay relay. This relay automatically cuts off the electrical power to the solenoid after a period of between 1 and 2 seconds. This provides sufficient time for the latch dog to be depressed and for the gate to clear the striker and proceed through its opening arc. The relay automatically recycles after use so that it is always ready for the next opening cycle of the gate.

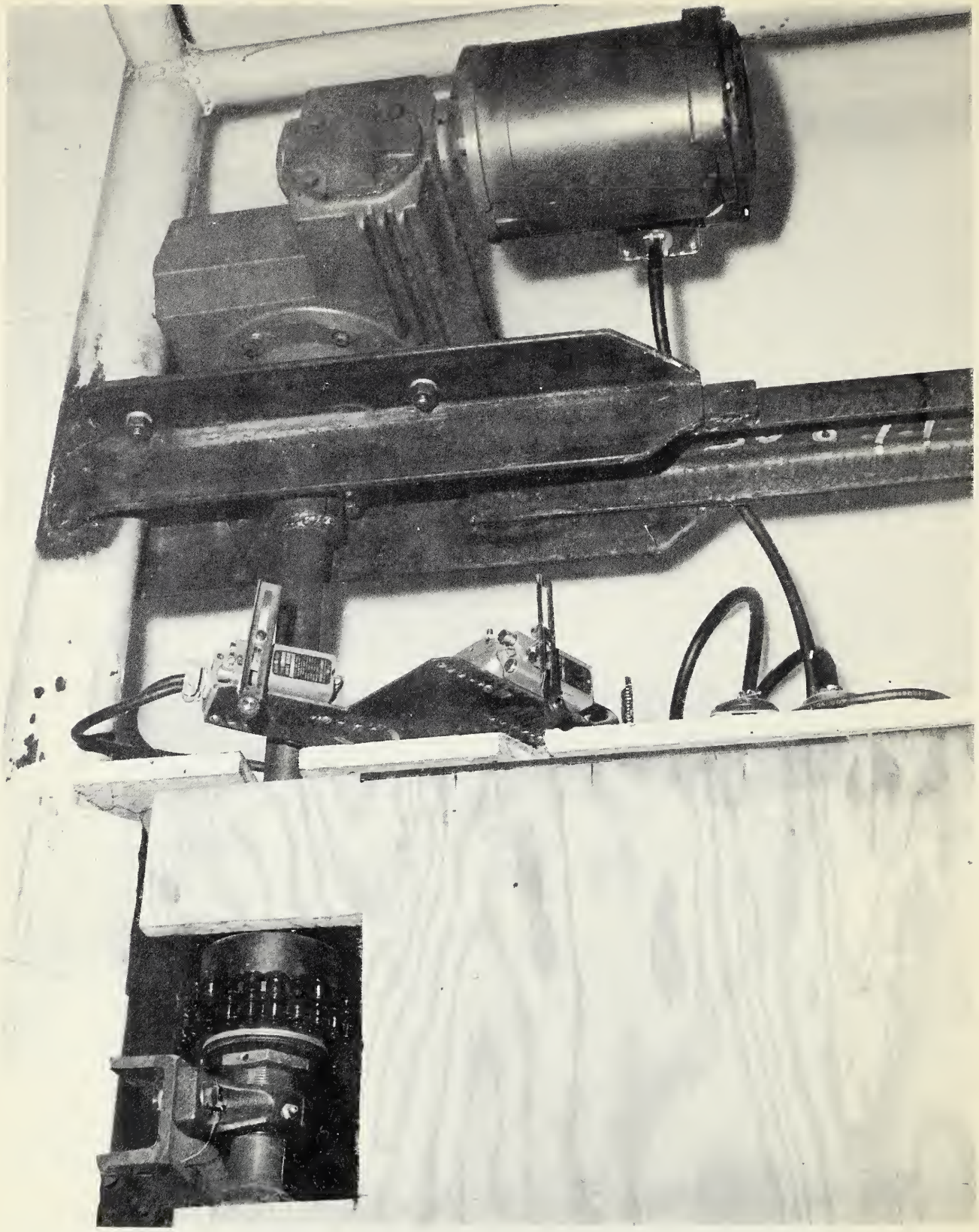

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Figure 3.--The electric motor and gear reduction drive used in the electrically operated gates.

LABORATORY TESTS

A test gate was built and the latching mechanism and electrical system were installed. The gate was run through slightly more than 50,000 cycles in the laboratory. During this testing, the return spring failed twice, and it was redesigned.

The latch mechanism was tested further in a special arrangement in which only the electric solenoid was cycled, so that only the latch mechanism operated, and not the gate. The latch mechanism was tested through 100,000 additional cycles. There were no failures of the individual components.

TESTS IN AN AUCTION MARKET SALES RING

Two gates equipped with the latching mechanism and electrical systems were constructed and installed in the sales ring of a livestock auction market (fig. 4). The gates were made of 2 3/8-inch O.D., 18-gage steel tubing, covered with

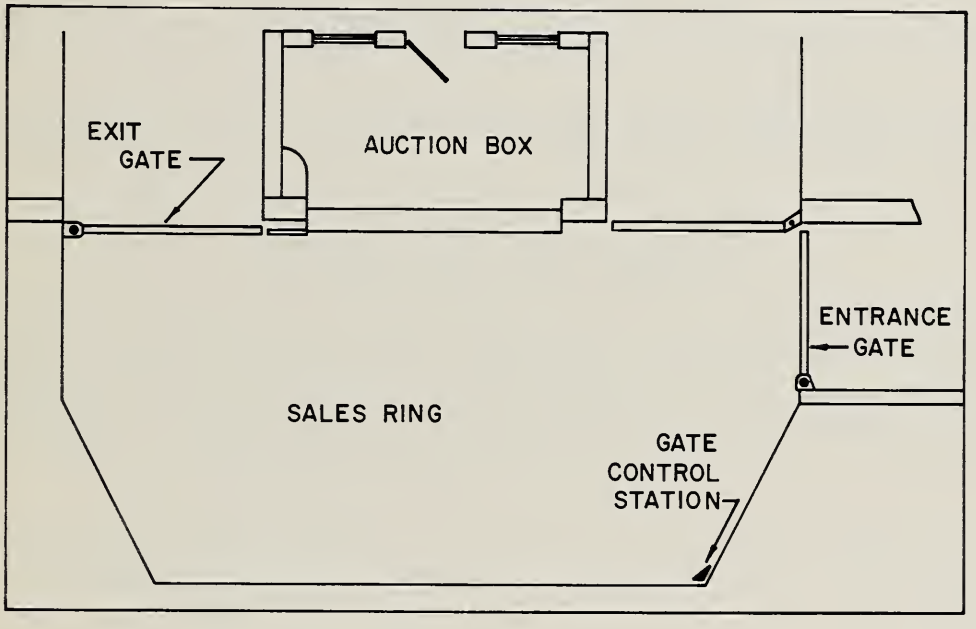

Figure 4.--Layout of the sales ring and auctioneer's box showing the location of the electrically operated gates and the control station.

3/4-inch fir plywood. Each gate was 91 1/2 inches long and 68 inches high and weighed 61 pounds (excluding the weight of the plywood and latch mechanism). A shatterproof glass window, 12 by 24 inches, was installed in each gate. The end of the gate away from the latch was equipped with machined shafts that would fit into a standard size bearing. The gates were hung with pillow block bearings, which were fastened to a rigid member of a building.

The entrance gate opened in one direction through a 90° arc. The exit gate was a two-way gate, opening through a 90° arc in either direction. The two-way gate had two complete latch assemblies--one on each side of the gate.

The control station for each gate was attached to a flexible cable so that the gates could be controlled from the sales arena or from the auctioneer's booth. Additional control stations can be used if it is desirable to control the gate from more than one place.

After some testing, the controls were mounted in the sales ring, and the ringmaster controlled the gates during the remainder of the tests. The gates were operated 5 days a week for approximately a year. It is estimated that the gates were used between 20 and 25 hours a week during normal operation. During the fall sales of large feeder cattle, the gates were used 30 to 35 hours a week. It is estimated that the gates were operated more than 1,000 hours through 100,000 cycles during the test period.

Two minor problems occurred during this time. The actuating arm on one of the latch mechanisms failed after 2 months, because the threads on the arm were not cut correctly. The facing on the slip clutch failed because improper facing material was supplied by the manufacturer.

Opening the gate with cattle crowded against it was not a problem at any time during the test in the market.

ESTIMATED COSTS AND BENEFITS

The initial cost of a set of two electrically operated, remotely controlled gates installed at the entrance and exit to the sales ring of a livestock auction market is estimated to be about $2,500. This estimate includes installation of all electrical wiring by an electrical contractor. Computed ownership and operating cost for the two gates is $550 annually.2/

The use of these two gates in an auction market makes it possible to operate the selling cycle with two fewer workers. Assuming a wage rate of $1.75 per hour, a livestock auction market which operated 5 days per week would reduce its labor cost by $7,280 per year. The net savings would be $6,730. Those markets operating less than 5 days per week would have proportionately lower savings; however, use of the gates on the sales ring should be beneficial on a market operating only 1 day per week.

Livestock were moved through the sales ring more quickly when the electrically operated gates were used so that there was a slight increase in the

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2/ Basis for depreciation is Internal Revenue Service Publication No. 456, U.S. Treasury Department. Interest was computed at 6 percent; taxes and insurance at 4 percent; and electricity at 2.7 cents per kw.-hr. Maintenance was estimated at $35 per year.

drafts of livestock sold per hour. This could be an important factor for those markets whose selling cycle frequently exceeds normal working hours.

The gates could be used in other parts of a livestock market, but data are not available to determine whether this would be advantageous from an economic standpoint. It is possible that volume production of electrically operated gates would reduce costs of the gates to the point where their use could be justified.

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